welcome to the
European Microkelvin Collaboration

CAPACITIES

MICROKELVIN Transnational Access Project Report

1. General information

Project number:	**TKK 03**	
Project Title:	**Dissipation in vortex motion**	
Project acronym:		
Lead scientist:[1]	**Title:**	Professor
	First name:	Victor
	Last name:	L'vov
	Birth date:	
	Research status/Position:	Professor
	New User:[2]	No
	Scientific Field:	Superfluid hydrodynamics
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	Home institution is MICROKELVIN partner:	**Yes** ☐ **No** X
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[1] The lead scientist indicated here is expected to participate in the campaign as a user of the infrastructure.
[2] Indicate 'Yes' only if the user has never visited the infrastructure before this specific project, otherwise write 'No'.

2. Project information

Please, give a brief description of project objectives: (250 words max)	Dissipation in superfluids at the lowest temperatures is of great current interest in the study of quantum systems. All standard mechanism of dissipation approaches zero in the zero temperature. In a rotating cryostat one can explore the motion of vortices by changing the rotation velocity and by comparing the responses when different boundary conditions or different initial conditions are imposed. The question is then how do vortices couple to changes in the externally imposed reference frame when the density of normal excitations is approaching zero? From measurements on both helium superfluids and Bose-Einstein condensed cold atom clouds so far we know that the superfluid with its vortices appears to remain coupled. What provides this coupling: are there new dissipation mechanisms which govern the superfluid dynamics in the zero temperature limit? The MicroKelvin collaboration provides an opportunity to study these questions experimentally in the fermion superfluid 3He-B by means of a rotating cryostat. With this apparatus 3He-B is cooled to below 0.2 Tc in rotation which can be controlled to within ± 1 circulation quantum. Measurements on the spin-up and spin-down of the superfluid component under varied conditions have shown that vortices do respond to changes in the rotation velocity down to very low densities of normal excitations, where their mean free path is much longer than the sample dimensions. However, dissipation strongly depends on vortex polarization, i.e. on the presence of inter-vortex and intra-vortex reconnection processes.
Technical description of work performed: (250 words max)	**During my visit to LTL we analyzed set of experimental data from rotating cryostat (related to spin-up and spin-down experiments) as well as data of numerical simulations in the vortex-filament approximations. This allows us to formulate physical hypothesis concerning possible mechanisms of the energy dissipations and to formulate tasks for additional numerical simulations. These simulations were performed during my stay in Helsinki.** **Their analysis allows us to understand why the rate of energy dissipation can be even less then in the regime of laminar flow. The numerical data concerning the vortex polarizations and the probability of vortex reconnections shed light and the main processes that govern the rate of the energy dissipations in the spin-up and spin-down set-ups.** **Essential part of time was devoted to systematization of available experimental and numerical data and to writing down first draft of the manuscript that will describes our achievements –see below:**
Project achievements (and difficulties encountered):[5]	**Both experimental and numerical studies indicate that the flow of vortices remains laminar in superfluid 3-He-B up to large superfluid Reynolds numbers about 1000 in a container with axial rotation symmetry. This is in contrast to the unstable rotational spin up and**

(250 words max)	**spin down of viscous fluids and of superfluid \$^4\$He. The reasons which reinforce the unusual stability of laminar flow are the rapidly decaying transients of the highly viscous normal component of He-3-B and the large superfluid vortex core radius about 10 nm, which reduces both surface pinning and vortex reconnections. We discuss the influence of finite amplitude perturbations on the stability of vortex flow in the limit of very small temperatures, when superfluid Reynolds number tends to infinity.**
Expected publications and dates:	• **Title: Stability of Vortex Flow in Superfluid He.** • **Authors: V.B.~Eltsov, R.~de~Graaf, R.~H"anninen, M.~Krusius (LTL) and V.S. L'vov (Weizmann).** • **To be submitted in Phys. Rev. Letts. Decmber 2009.**
Submission date of user group questionnaire:	November 23. 2009

Completed Project Reports should be returned to MICROKELVIN Management Office (Leena.Meilahti@tkk.fi, Fax: +358 9 4512969).